REVIEW OF EPA REPORT,
"SITE EVALUATION FOR ORONOGO-DUENWEG MINING BELT"
JASPER COUNTY, MISSOURI

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GENERAL STATEMENT

The report entitled Site Evaluation for Oronogo-Duenweg Mining Belt, Jasper County, Missouri prepared for the EPA under date of March 1988, has been reviewed. Although the report was written to evaluate the "health risks" associated with the Oronogo-Duenweg Mining Belt of Jasper County, Missouri, it is essentially a treatise on EPA drinking water standards, plus a lengthly disscussion on the medical effects from the ingestion of certain metallic elements. Of the 50 pages in the report only seven pages were devoted to the historical and geological features of the subject area.

The site area chosen for this study lies within one of the foremost metallogenic provinces of the United States, wherein scattered occurrences of zinc and lead mineralization were deposited at relatively shallow depths, some 20 to 40 million years ago. The site itself encompasses the largest known area of zinc-lead mineralization in southwestern Missouri, covering a belt some 10 miles long by up to 2 miles wide. In this area local concentrations of zinc and lead minerals are found as erratic masses in zones of decomposed cherty limestone, lying at variious depths ranging from the surface downward to about 250 feet.

In the upper reaches of these deposits the zinc-lead minerals have been subjected to intense oxidation from downward percolating groundwaters for the past 20 million years. Under such conditions the orginal zinc and lead sulfides are converted to carbonates and silicates, with the more soluble metallic salts being passed on to the surface streams through springs and seeps. It is of importance to note that the mineralized areas undergoing oxidation constitute only a small portion of the entire district, and that they are confined to open-space solution structures surrounded by an unaltered sequence of relatively impervious cherty limestones. It was the natural discharges of mineralized waters from springs and seeps that served as prospecting guides for the early miners.

Mining operations from both the sulfide and oxidized mineral deposits have been conducted by literally hundreds of different companies, commencing in the early 1850's and lasting, with but few interruptions, until the early 1950's. Although mining operations were halted by declining metal prices, this subdistrict still contains the largest tonnage of known ore reserves in southwestern Missouri. Ore reserve studies made by the U. S. Bureau of Mines (Ruhl et al., 1949), and (Ruhl, 1950) for "Sheet-Ground" ore blocks in the Prosperity, Caterville, and Webb City areas show a total of 20,647,800 rock tons, having a recoverable grade of 2.93 percent as zinc concentrates, and 0.23 percent as lead concentrates. Ore reserve estimates for the entire Oronogo-Duenweg area by Ruhl (1943) show a total of 34,863,500 rock tons, having a combined concentrate grade of 2.80 percent. At today's metal prices these ore reserves are nearing profitable mining levels.

The environmental "hazards" as cited by the EPA report include, (1) Damages to life and property from open pits and mine cave-ins; (2) Groundwater contaminations from oxidizing ore minerals; (3) Surface water contaminations from mineralized springs and seeps; (4) Seasonal rainfall runoffs from oxidizing tailing piles; and (5) Transported accumulations of zinc and lead minerals in stream botton alluvium. Most of these so-called "health risks" are either of minor consequence, or are confined to limited areas where they are locally controlled. A more complete discussion of these "hazards" is presented on pages 18 through 23 of this reort.

From reading the EPA report one would assume that the mining companies of the area were responsible for the emplacement of the ore-formng minerals, plus the oxidation products derived therefrom. The report also completely disregards the geological history of the area, and ignors the conclusions from two previous ground and surface water investigations by the U. S. Geological Survey, Feder et al. (1969), and Barks (1977). In addition the repeated references to the toxic ground and surface waters as being "mine related" are cheap-shots, and are not appropriate for this situation.

In order to place this mining belt into its proper perspective, a number of misleading statements in the EPA report need to be clarified, expanded, or corrected. These items are listed below, and are described in the following text.

1. SITE LOCATION
2. GEOLOGLICAL HISTORY
3. SOLUTION STRUCTURES
4. ORE DEPOSITS
5. MINING HISTORY
6. ORE RESERVES

7. CENTRAL DRAINAGE DISTRICT, JASPER CO.

SITE LOCATION

The site location as described in the EPA report is very vague, with it being depicted as a 10 square mile area (6,400 acres), lying near Joplin, Jasper County, Missouri, and being situated on a portion of the Webb City, and Joplin-East quadrangle sheets. The outline of the area, as shown of their "Location Map", designated as (Figure 1), traces an elongated zone having an irregular boundary, extending from near Oronogo southward to near Duenweg. On what basis this area outline was drawn is not known, since it fails to include a number of mining localities lying immediately adjacent to its northern, western, and southern boundaries.

A more precise definition of the area is needed.

In 1933 the landowners of the Oronogo-Duenweg Mining Belt formed the Central Drainage District of Jasper Coounty, a public, not for profit, corporation for the collective pumping of the area to reopen the mines, which had been inactive since the 1918-1920 period. As a result of extensive geological and hydrological studies, the Central Drainage District established boundary lines to include the groundwater drawdown areas to dewater each of the eight loosely connected drainage basins, or water "Pools", to the "Sheet-Ground" mining depths.

The legal descriptions of the boundary lines, as established by the Central Drainage District, are recorded in the <u>ARTICLES OF ASSOCIATION</u> of that organization, and are shown on the base map accompanying this report. The area so-defined covers approximately 17,560 acres, and extends in a north-south direction, from 1½ north of Oronogo, southward to 1½ miles south from Duenweg, a distance of approximately 10½ miles. In width the area varies from 2 to 4 miles in an east-west direction.

The above area covers the subsurface drainage limits for the dewatering of the Oronogo-Duenweg Mining Belt to an average depth of 200 feet, and includes those adjacent mining sites omitted in the boundaries as drawn for the EPA report.

A more complete description of the Central Drainage District of Jasper County, Missouri, is presented on pages 15 through 18 of this report.

GEOLOGICAL HISTORY

The localized occurrences of contaminated ground and surface waters are directly related to a natural series of events that occurred during the past 350 million years of the area's geological history. In order to properly evaluate these problems a knowledge of these events is of utmost importance.

The surface rocks of the area consist of a 300 to 400 foot thickness of indurated cherty limestones of Mississsippian (Paleozoic) age, which are overlain by scattered erosional remnants, or outliers, of shales, sandstones, and thin coal beds of Pennsylvanian (Paleozoic) age. These sediments are respectively of marine and terrestrial origin, and were deposited some 350 to 300 million years ago. During the late part of the Paleozoic Era the area was uplifted above sea level, and has remained dry land since that date.

The next time span of 230 million years, consisting of the last 75 million years of the Paleozoic Era, plus the 155 million years of the Mesozoic Era, was a lengthly period of surface erosion that resulted in ultimate base-leveling. The surface erosion removed much of the overlying Pennsylvanian sediments, and exposed the underlying Mississippian limestones to the development of a karst-like topography in selective areas. This Mesozoic period of subsurface limestone dissolution formed spotty occurrences of caverns, bed shrinkages, collaspe structures, and sink-holes. Many of Pennsylvanian outliers in the area today are truncated collaspe structures infilled with Pennsylvanian sediments. These are the open-ground structures that later became the host sites for the zinc-lead mineral deposits of the area. At the close of the Mesozoic Era the land mass was reduced to a nearly flat, featureless plain lying only moderately above sea level, with the subsurface openings being flooded by sulfo-saline brines.

The next 50 million years, lasting from 70 to 20 million years ago, comprised the greater part of the Tertiary Period of the Cenozoic Era, and was the tlme interval during which the zinc-lead ore minerals were deposited. This period was characterized as one of intense chemical erosion, or lateritic weatherilng, that was accompanied by the gradual doming of the Ozark Region. Under these conditions the more soluble constituents of the surface rocks, together with the metallic trace elements, were dissolved and passed downward into the ground water system. As the doming of the Ozarks continued these ore-bearing fluids migrated westward, depositing metallic sulfides in favorable openings under the reducing conditions of the retreating sulfo-saline brines. This period of ore deposition lasted some 50 million years, and was abruptly halted about 20 million years ago, during the Pliocene Epoch of the Tertiary Period, with the final uplift of the region to near its present elevations.

The lsst 20 million years includes the Pliocene portion of the Tertiary Period, plus the entire Quaternary Period of the Cenozoic Era, and was a time of largely physical erosion that carved the present topography. The character of the groundwaters was also changed through the influx of bi-carbonate recharge water, with the ore-bearing fluids and the residual brines being flushed downdipward. Remnants of these former solutions still exist as pocket-like entrapments.

The downward cutting erosion has exposed many of the near surface zinc-lead deposits to the effects of surface oxidation. In these instances the sulfide ore minerals have been converted to carbonates and silicates, with the leachates being discharged to ground and surface waters. This oxidation process has been in progress for the last 20 million years (and is still active today) forming localized contaminations of ground and surface waters that have been known since the times of earliest settlement.

The infiltrations of oxidizing surface waters have also been responsible for the localized devevelopment of a second set of subsurface dissolution structures in the form of caverns, limestone bed removals, and sink-holes. These more recent zones of underground porosity are devoid of ore forming minerals, but if encountered in drilling, they provide localized storage areas for shallow groundwater supplies.

SOLUTION STRUCTURES

The Oronogo-Duenweg Mining Belt is located along one of the more intense zones of limestone dissolution within the Tri-State District. In this area the solvent action of the Mesozoic groundwaters created a karst-like topography covering some 13,000 acres, through the dissolution and removal of thousands of tons of limestone. The results of this solvent action have formed a a subterranean zone of altered sediments, consisting of caverns, collaspe structures, and sink-holes. The geological maps of the belt by the U. S. Geological Survey (1907), and the Missouri

Geological Survey (1942) show more than 35 sites, collectively covering approximately 1,300 acres, where collaspe structures and sink-holes have broken through to the surface.

These broken ground zones are largely composed of fragmental and compacted chert, plus a jumbled mass of infill material consisting of shales, sandstones, secondary carbonate rocks, jasperoid, and insoluable residues. They are extremely porous, containimg large volumes of water, with the surface break-throughs acting as conduits for both recharge and discharge water. Where the limestone dissolution has been intense, many of the solution structures have coalesced with one another, but in all cases the zones of rock deformation are surrounded by undisturbed areas of limestone, locally called "bars".

The near surface solution structures containing ore deposits are highly susceptible to leaching by oxidaton, while those lying below the fluctuating water table levels remain inert under naturally alkaline groundwater conditions.

ORE DEPOSITS

The Oronogo-Duenweg Mining Belt was the major zinc-lead producing area in the southwestern Missouri portion of the Tri-State District, being located along a northwest-southeast alignment of closely spaced solution structures of varying sizes and shapes. Important mining centers along the 10 mile length of this trend, from north to south, include Oronogo, Webb City, Carterville, Prosperity, Porto-Rico, and Duenweg.

Ore Bodies

The individual ore bodies are found in a multitude of sizes and shapes, and at various levels, or combination of levels, extending from the surface downward to about 250 feet. In outline the ore bodies closely conform themselves to the boundaries of the deformed country rocks. The ore minerals were deposited as open-space fillings in fragmented breccias, as flat seams in compacted chert, or as disconnected masses in the more decomposed portions of the solution structures. Disseminated mineralization occurring in secondary jasperoid was not common in this subdistrict, which resulted in most of the ore being "free-milling", yielding exceptionally low grade tailings from gravity separation mills.

Ore Minerals

The mineralization of the ore deposits is principally the sulfides of zinc and lead, with lesser amounts of iron, copper, and other trace elements including cadmium, germanium, gallium, and indium. In the near surface ore deposits natural oxidation has converted many of the sulfides to sulfates, carbonates, and silicates, with the more soluble products being passed on to the ground and surface water This natural leaching by oxidation is an ongoing process, and cannot be halted short of a reversal of the area's geological history.

Trace Elements

In addition to the above ore minerals, the EPA report lists a number of trace metallic elements that were revealed from a previous ground and surface water study by Barks (1977). These elements included aluminum, chromium, cobalt, manganese, mercury, nickel, and silver. Of these elements the EPA report considers nickel and mercury (in addition to zinc, lead, and cadmium) as occurring in objectionable quantities in certain shallow water wells, and streams associated with tailing pile runoffs.

All of the reported trace elements, with the exception of mercury, are common constituents of the carbonate rocks of the Ozark Region (Grawe, 1945), and are easily dissolved, transported, and concentrated through the normal processes of rock weathering. The origin of the mercury is mysterious, but its presence from certain tailing pile runoffs would suggest an outside source not related to the ore deposits.

The existence of objectionable quantities of zinc, lead, cadmium, and nickel in wells and water discharges, located in zones of metallic mineral deposits, is not surprising. Such isolated concentrations are to be expected in any metallogenic province as widespread as the Tri-State District, and are bound to occur wherever mineral deposits are undergoing oxidation, whether in a mining area or not.

Types of Ore Deposits

The ore deposits of the Oronogo-Duenweg Mining Belt can be classified into four general types, as follow:

1. Upper Ground Depostis. -- The upper ground ore deposits are those that outcropped at the surface, and extended downward for as much as 100 feet. They are usually found as erratic masses occurring in the form of runs, pods, or circles, localized in zones of fragmented chert and limestone, mixed with decomposed shales, sandstones, and other insoluble residues. Since their upper portions were above the water table, they were the sites for the earliest mining in the subdistrict. Due to the rotten nature of the enclosing host rocks, many of the mines in this zone required the use of extensive timbering for ground support.

1. Massive Breccias. -- The massive breccia deposits usually occur as lenticular masses lying at depths ranging from 100 to 175 feet. The host rocks are mainly fragmented breccias formed by collaspe structures, and are moderately cemented by secondary carbonate rocks, and/or jasperoids. The ore minerals are widely dispersed as open space fillings ,and as occassional disseminations. These deposits can usually be mined by open-stopping, leaving pillars for roof support, and are locally referred to as "confused ground".

3. Sheet-Ground Deposits. -- The sheet-ground ore deposits are found at depths ranging from 175 to 225 feet, and occupy the most extensively mined zone in the Oronogo-Duenweg Mining Belt. In this zone the ore minerals occur as thin "sheets", filling voids and seams along the bedding planes of a compacted chert. Ore deposits of this type have thicknesses varying from 6 to 25 feet, and extend horizontally over areas as great as 160 acres or more. The ore is typically very low grade, but the deposits lend themselves to large tonnage mining operations, that extend throughout the subdistrict. Although the mining of this zone was abandoned in former years in favor of richer mines in Oklahoma, substantial tonnages of ore reserves are still present.

4. Reeds Spring Deposits. -- The Reeds Spring deposits lie below the Sheet-Ground zone, and occur as irregular, narrow and compound runs of relatively high grade mineralization.

They usually occupy enlarged solution joints filled with broken rock and selvage, lying just below the top of the Reeds Spring formation at a depth range of 200 to 250 feet. Because of their narrow and elongated planary dimensions, and being situated below normal prospecting depths, only a few of these deposits have been discovered. The limited mining from this zone is restricted to the northern portion of the subdistrict, but other occurrences are known that might be expanded through further prospecting.

MINING HISTORY

Mining in this subdistrict began in 1850 with the early development of the near surface ore deposits at Oronogo, and by 1851 shallow mining operations had been extended into the Webb City, Carterville, Prosperity, Porto Rico, and Duenweg mining camps. All of these mines were operated by landowners, or lessees, on property acquired through homestead rights. During the Civil War years of 1860 through 1865, mining was halted by local battles between the Federal and Confederate forces. In 1866, with peace restored, the shallow mining camps were quickly reactivated, and worked for their lead content, with the zinc ores being separated as worthless rubbish. During the 1866-1870 years the lead concentrates were locally smelted at primitive Scotch-Hearth furnaces at Oronogo and near Duenweg.

The decade from 1870-1880 was one of rapid expansion, marked by the coming of the first railroad, and the introduction of steam-powered mine pumps. Mine pumping allowed the development of the deeper massive breccia ore deposits, and the railroad provided access to the eastern zinc smelting markets. With these innovations in place, equipment was acquired for the construction of crude ore dressing facilities. The small lead smelter at Oronogo was phased out in 1877, with most of the lead concentrates going to smelters in Joplin, and a short-lived facililty in Webb City. By the end of the decade zinc production exceeded that of lead, and coal-fired zinc smelters had been constructed at Weir City and Pittsburg in Kansas.

The period from 1880 to 1900 was marked by the development of the deeper, large tonnage Sheet-Ground mines, which had been discovered by use of steam-powered, churn-drill prospecting rigs. Sheet-Ground mining began to boom, with the installation of vastly improved mining and milling techniques. The discovery of natural gas in northeast Oklahoma and southeast Kansas in the early 1890's brought the demise of the coal-fired zinc smelters, and by 1894 they were replaced by 18 new gas-fired plants, of which 10 were in Kansas, 6 in Oklahoma, and 2 in Arkansas.

The period from 1900 to 1920 was the years of peak production in the subdistrict, with a total of 146 large Sheet-Ground mines being operated from 1909 to 1919, in addition to numerous smaller outfits mining the upper ground and massive breccia ores. Maximum production was reached during 1916 and 1917, but declined rapidly during 1918 and 1919, with the sharp drop in metal prices following World War I. By 1920 most of the mines in the area had closed, with the underground workings being allowed to fill with water. As these operations were halted, many of the mining companies moved their mining and milling equipment to the newly discovered, richer mines in Oklahoma.

This was the period during which the American Zinc, Lead & Smelting Co. entered the subdistrict, having operated the Hockaday mine, south of Oronogo, from 1904 through 1913; and the Davey mine, south of Carterville, from 1905 through 1920.

From 1920 through 1934 mining in the area was limited to a few small gougers working the near surface ores. In 1934, with expectations of better metal prices from their Depression lows, the Eagle-Picher Co., together with the Childress Interests, and rights granted by the Central Drainage District of Jasper Co., commenced pumping operations to dewater the entire subdistrict. By 1935 the northern portion of the Webb City area and the Oronogo area were drained, with limited Sheet-Ground mining being resumed in the north Webb City area, and open-pit mining at Oronogo being commenced. The Sheet-Ground mining was suspended in 1940, because of continued low metal prices, but mining at Oronogo was continued by the Oronogo Mutual Mining Co., and others, until 1948.

Several inportant developments were brought about in 1942 by the U. S. Government's Premium Price Plan to encourage zinc and lead production for the World War II effort. Amoung these was the construction in 1944 of underground bulkheads to separate the Webb City mine water from that at Oronogo. With this installation in place, the mine pumps in the southern portion of the subdistrict were pulled, leaving only the pumps at Oronogo in operation. Also during the subsidy period the Kansas Exploration Co. (St. Joe) opened and operated its Buckingham-

Gibson mine located 1 mile north from Oronogo from 1943 through 1948; the Federal Mining and Smelting Co. (Asarco) opened a group of mines at Duenweg, milling its own and custom ores from 1943 through 1951; and the Eagle-Picher Co. subleased mines in the north Webb City area, and operated the Needmore mine at Oronogo during the period 1936 through 1946.

Following the cessation of mining at Oronogo in 1948, and at Duenweg in 1951, the subdistrict was again allowed to fill with water. The only other mining of consequence since those dates was the experimental Sheet-Ground mining during the years 1965 to 1967 at the Hyde Park mine, north of Duenweg, by the Childress Interests. At this location the ground was dewatered, and selectively mined on a 6-foot heading to prove that a 6 percent concentrate recovery could be maintained over a mining period of one year. With the completion of this successful test the mine was closed, and allowed to flood with water.

At the present time with zinc metal prices in the $0.70 per pound range, equivalent to $420.00 per concentrate ton, mining interests are being revived. A local Joplin concern is currently securing Mining Leases in the north Duenweg area, and has plans to reopen this area for Sheet-Ground mining. Mine pumping may begin this Fall through an AUTHORIZATION TO DISCHARGE, granted on October 7, 1988 by the Clean Water Commission, Missouri Department of Natural Resources.

Mine Production

Mine production statistics for the years 1850 through 1906 are very incomplete, being recorded by a number of different agencies with little or no continuity. However, starting with 1907, the production records from individual mines have been assembled on a annual basis by the U. S. Geological Survey (from 1907 through 1923), and by the U. S. Bureau of Mines for the years after 1924. These annual production figures for individual mines are recorded in the "confidential" files of the U. S. Bureau of Mines, of which the St. Joe Lead Co. has a copy.

This subdistrict was the largest zinc-lead producer in southwestern Missouri, and for a number of years prior to 1918 was responsible for most of the Tri-State mine production. According to the Bureau of Mines (Ruhl, 1950), as of 1932, the total estimated and factual mine production was 84,000,000 tons of crude ore, yielding 1,477,000 tons of recoverable zinc, and 488,000 tons of recoverable lead, representing a combined metal recovery of 2.33 percent. The estimated production for the years 1933 through 1951 (by the writer) is 6,300,000 tons of mine ore, which brings the grand total production from 1850 through 1951 to approximately 90,300,000 rock tons.

A table showing the distribution of this tonnage is as follows:

Source	Period	Area	Estiamted Tons Mined
USBM	1850-1932	Entire Subdistrict	84,000,000
(*)	1933-1935	Misc. Areas	100,000
(*)	1936-1947	Oronogo	3,500,000
(*)	1936-1951	Webb City	700,000
(*)	1943-1948	N. Oronogo	500,000
(*)	1943-1951	Duenweg	1,500,000
	TOTAL		90,300,000

Note: (*) Estimates by writer

ORE RESERVES

The Oronogo-Duenweg Mining Belt contains the largest block of ore reserves known today in the Tri-State District (Ruhl, et al., 1949), consisting of some 20 to 35 million tons of proven, probable, and possible ore having an estimated grade of 2.80 percent as recoverable zinc and lead concentrates. These ore reserves are principally the unmined Sheet-Ground deposits that were abandoned in 1918, following the collaspe of the zinc and lead markets at the close of World War I. At today's metal prices these reserves represent a valuable natural resource worth in excess of 250 million dollars, and under proper incentives could be profitably mined.

Engineering and geological studies to dewater and reactivate this mineralized belt were commenced in 1933 with the formation of the community owned, Central Drainage Distict of Jasper County. This organization made extensive hydrological and geological investigations, which included ore reserve estimates by Mr. Victor Rakowsky, mining consultant of Joplin, Mo. Rakowsky's report, dated December 1933, showed a developed (proven) ore reserve of 14,078,890 rock tons, having a combined zinc-lead grade of 5.00 percent as recoverable concentrates.

In September 1942, Mr. D'Arcy M. Cashin, mining consultant for Brown & Root of Houston, Texas, reappraised the the area for a large tonnage, unitized mining operation. He estimated the tonnage for proven, probable, and possible ores to be 36,000,000 rock tons, having a combined zinc-lead concentrate recovery of 3.33 percent.

Later in January 1943, the William M. Stewart Engineering Co. of Joplin, Mo., completed a more detailed ore reserve study, that showed a total of proven, probable, and possible ores to be 36,549,000 rock tons, having a recoverable zinc-lead concentrate grade of 2.80 percent.

Also at this time, as part of the World War II effort, the War Production Board commissioned the U. S. Bureau of Mines to review these ore reserves for a possible Governmental Financed mining operation. The results of this study, War Minerals Report No. 209, dated May 1943, showed the total of proven, probable, and possible ores to be 34,863,500 rock tons, having a combined zinc-lead concentrate recovery grade of 2.80 percent. Of the proven ore reserves, 18,863,500 rock tons, grading 2.80 percent combined concentrate recovery, were situated as semi-contigeous blocks in the Prosperity-Carterville-Webb City areas.

Since the Brown & Root Co. held the Mining Leases to this portion of the mining belt, they requested a loan from the War Production Board to start a 4,800 tons per day mining operation. This loan was to be approved contingent upon a check drilling program funded by the Metals Reserve Corp., with Brown & Root acting as agents. This exploration program was commenced in June 1943, and terminated in January 1944, with 210 drill holes being completed. The drilling results, as appraised by the U. S. Bureau of Mines (Ruhl, 1950), showed the Prosperity-Carterville-Webb City portion of the mining belt to contain 20,647,800 rock tons, having a recoverable zinc-lead concentrate garde of 3.16 percent. Because of subsidy curtailments during 1944 by the War Production Board, this mining venture was never activated.

From the foregoing review it is obvious that the Oronogo-Duenweg Mining Belt contains a substantial tonnage of Sheet-Ground ore reserves awaiting improved economic conditions.

A summary of the various ore reserve calculations is presented in the following table.

ORE RESERVES - - ORONOGO-DUENWEG MINING BELT

Date	Source	Area	Rock Tons	Grade Zn+Pb Conc.
Dec. 1933	V. Rakowsky (1)	Webb City	14,078,890	5.00
Sep. 1942	D. M. Cashin (2)	Entire Area	36,000,000	3.33
Jan. 1943	Stewart Eng. Co.	" "	36,549,000	2.80
May 1943	War Min. Rpt. 209	" "	34,863,500	2.80
Jul. 1949	U.S.B.M. (3)	Pros.-Carter.-Webb City	20,647,800	3.16
Jan. 1950	" " (4)	Pros.-Carter.-Webb City	20,647,800	3.16

Notes

(1) Private Report to Board of Supervisors, Central Drainage district, covering proven ore reserves in Webb City area only.

(2) Private Report to Brown & Root Inc., Houston, Texas, covering entire mining belt.

(3) Ruhl, Otto; Allen, Simeon A.; and Holt, Stephen P.; **ZINC-LEAD ORE RESERVES OF THE TRI-STATE DISTRICT, MISSOURI-KANSAS-OKLAHOMA**, U.S. Bureau of Mines, Report of Investigations, No. 4490, July 1949.

(4) Ruhl, Otto; **INVESTIGATION OF THE ORONOGO-WEBB CITY-DUENWEG ZINC-LEAD DISTRICT, JASPER COUNTY, MO.**, U.S.Bureau of Mines, Report of Investigations, No. 4598, January 1950.

CENTRAL DRAINAGE DISTRICT OF JASPER COUNTY

General Statement

With the Sheet-Ground mines of the Oronogo-Duenweg Mining Belt being unproductive and water flooded since 1918, the landowners of the area, anticipating an economic turnaround, organized in 1933 the Central Drainage District of Jasper County. This association was a non-profit, public corporation, with its government being vested in a Board of Supervisors elected by the property owners. The corporation was chartered under the Drainage Laws enacted by the Missouri Legislature, during Sessions of 1929, 1933, and 1934.

The purpose of this organization was to promote the mine pumping and reopening of the zinc-lead mines within the Drainage District. The boundaries of the District included the entire Oronogo-Duenweg Mining Belt, and extended outward to cover the underground drainage areas established by their hydrological studies. The lands within the Drainage District are described in the Aticles of Association, with the boundary outline being shown on the accompaning map. Although this organization has been inactive since 1947, its charter and corporate shell, to our knowledge, have not been revoked.

At the outset the Drainage District sponsored a series of hydrological, geological, and engineering studies to determine the best approach to reactivate this mining belt.

Water Pools

The results of the hydrological studies showed that the area was not a single interconnected reservoir of upper aquifer groundwaters, but was a series of disconnected, or poorly connected individual water-bearing zones, or "pools". Each pool was a water basin of its own, characterized by a group of closely spaced, variously shaped, subsurface areas of porous rock formed by limestone dissolution. These solution structures were the host zones for both the ore deposits, and the groundwaters of the area. Collectively these subsurface water zones were grouped into 8 separate and distinct pools for pumping purposes. A table showing the underground water pools, together with their storage capacity in gallons, is as follows:

WATER POOLS
ORONOGO-DUENWEG MINING BELT

(DAta from reports of Central Drainage District of Jasper Co.)

Drainage Area Pool Nos.	Location	Storage Billion Gallons
Northwest	Oronogo	----
No. 1	N. Webb City	2.50
No. 2	NE. Webb City	0.90
No. 3	Webb City-Carterville	0.15
No. 4	Johnstown	0.12
No. 5	Prosperity	3.00
No. 6	Porto Rico	1.00
Southeast	Duenweg	----
	TOTAL (Ex. Oronogo & Duenweg)	7.67

Mine Pumping

Mine dewatering during the production period from 1850 to 1918 was accomplished through the combined efforts of the landowners and the many mining companies, utilizing numerous pumping stations. Until about 1880 most of the mining was conducted on levels lying above 100 feet, with the mine water being handled by crude, horse-powered lift pumps. After 1880 the use of steam-powered, deep-well pumps became standard practice, with the groundwater levels being lowered to the Sheet-Ground depths of approximately 200 feet. This groundwater level was maintained until the general shut-down of the mines during the 1918 to 1920 period, after which the underground workings were allowed to fill with water.

With the revival of mining interest in 1933 by the Central Drainage District, this organization was successful in inducing the WPA to initiate a flood protection project, to include surface drainage channels and levees for water diversions. This construction work was completed in 1935 after an expenditure of several hundred thousand dollars.

Mine dewatering under the auspices of the Central Drainage

District began during 1935 in the Oronogo and No. 1 Drainage areas, through arrangements made to the Childress Mining Interests. Later that same year the pumping rights were assigned to the Eagle-Picher Co., who placed a series of 14 pumping stations stretching for ten miles from Oronogo southward to Duenweg. By 1938 most of area had been dewatered to the Sheet-Ground level, but with no improvement in metal prices, all pumping south of the No. 1 Drainage Area was suspended. From 1936 through 1942 Sheet-Ground mining was activated in the Oronogo and No.1 Drainage Areas, with production being commenced at the large Oronogo open-pit mine. During the month of May, 1943, all mining was temporarily halted by a disastrous flood that closed the mines until December of the same year. After the flood water had been pumped, mining was resumed in the Oronogo area until its final cessation in 1951.

From the experience gained during the 1935-1938 mine pumping period, it has been estimated that this mining belt can be dewatered again in 6 months time, through the utilization of of 17 pumping stations equipped with 9-inch turbine pumps, having a combined capacity of 26,000 gallons per minute, (Ruhl et al., 1949).

Oronogo Bulkheads

During the 1936 to 1942 mining period the Sheet-Ground workings at Oronogo were extended southward and joined with mines on that same level in the No. 1 Drainage Area. With this underground connection these two drainage areas became a single water basin for pumping purposes. In May, 1943, the area was deluged by a three day (15-inch), record breaking rainfall, causing the streams of the area to overflow and enter the mines through poorly protected shafts, drill holes, and mine cave-ins. As a result of this flooding, the mines in the Oronogo and No. 1 Drainage Areas were shut-down for six months for dewatering.

In order to prevent such catastrophes in the future, two large concrete dams, or bulkheads, were constructed underground to separate the groundwater of the No.1 Drainage Area from that of the Oronogo Drainage Area. The bulkheads were placed beneath the northern side of the Center Creek Bottoms, located in the No. 1 Drainage Area, and thus would prevent the inflow of flood waters from the lowlands to the south into the Oronogo mine workings. After the bulkheads were completed in 1944, the pumps in the No. 1 Drainage Area were pulled, with only the pumps at Oronogo being operated for the remainder of the mining period that lasted until 1951.

HAZARDS IDENTIFIED BY EPA

General Statement

The Site Evaluation Report prepared for the EPA, dated March 1987, identifies a number of physical and chemical environmental problems in the Oronogo-Duenweg Mining Belt that may impose "health risks" to the local population. In describing these "hazards" the report goes so far as to infer that all of these problems are directly related to the former zinc-lead mining operations in the area. With the exception of isolated physical distrubances caused by ground subsidences, this inference is far from correct. The remaining "hazards" are all of a chemical nature, and consist of localized areas of ground and surface water contamination caused by the natural oxidation and erosion of near-surface ore deposits emplaced some 20 to 40 million years ago.

The main concern of the EPA report centers on one of the localized areas of zinc-lead mineralization that are widely scattered throughout the Tri-State District. These mineralized areas occupy ancient dissolution structures occurring in the cherty limestones, that also contain the shallow, or upper aquifer, groundwater zones. Over most of the district the groundwater quality from the shallow aquifer is generally acceptable, but can vary widely because of recharge from surface contaminations. The surface waters likewise show variations in quality due to isolated instances where spring flows, seepages, and rainfall runoffs from oxidizing mineral deposits are present, and also from various industrial wastes.

Ground and surface warter studies in 1969 by the U.S. Geological Survey and the Missouri Geological Survey, and in 1977 by the U.S. Geological Survey have shown these situations to be of relatively minor importance, with the groundwaters from the mineralized zones being avoided for drinking water, and with the effluents derived therefrom being either rapidly precipitated, or diluted to reasonable levels in short distances.

These previous ground and surface water studies are:

Feder, G. L.; Skelton, John; Jeffery, H. G.; and Harvey, E. J.; Water Resources of the Joplin Area, Mo.: U. S. Geological Survey, Water Resource Division; and Missouri Geological Survey and Water Resources, Water Resources Report 24; March 1969.

Barks, James H.; Effects of Abandoned Lead and Zinc Mines and Tailings Piles on Water Quality in the Joplin Area, Missouri: U. S. Geological Survey, Water-Resources Investigations 77-75; August 1977.

The "so-called" hazards as identified by the EPA are listed below, and are reviewed in the following text.

1. Mine Subsidences
2. Groundwater Contaminations
3. Surface Water Contaminations
4. Runoffs from Mill Tailings
5. Stream Sediments

Mine Subsidences

The EPA report cites a number of physical damages to the surface resulting from past mining operations, such as open mine shafts, subsided areas having steep, unstable slopes, and open pits containing deep pools of water. Although ground distrubances of these types are present in the scattered areas of near-surface mining, they are not as widespread as the report would indicate. The responsibilities to protect these areas from accidents to people or wandering livestock belongs to the local landowners, and not to the taxpayers, nor the EPA.

The property owners are very aware of these problems, and over past years have filled, or placed timbered covers on many of the old shafts, and discouraged trespassing by erecting barriers and posting "Keep-Out" signs. In some localities the surface has been restored for commercial development, and for use as parks and recreational areas. In those areas containing large tonnages of Sheet-Ground" ore reserves, the landowners are desirous to keep the former production shafts available for future mining purposes. Restoration efforts are not practiced where tailing loading operations are contemplated.

Groundwater Contaminations

The Site Evaluation report leaves the impression that the metallic ion concentrations found in certain water wells within the Oronogo-Duenweg area have resulted solely from downward leaching in former mining sites. This impression is not entirely correct, in that (1) downward leaching of metallic ions is not restricted to only mining areas, but can occur anywhere near-surface ore minerals are undergoing oxidation; (2) the downward leaching is not something of recent origin, but has been in progress for the past 20 million years; and (3) the groundwater concentrations of metallic ions are not of regional extent, but are confined to localized solution structures containing ore-forming minerals.

The EPA report cites groundwater analyses from 11 water wells, randomly spaced within the area, sampled by Barks (1977), only one of which, well No. 204, showed metallic cotaminations exceeding drinking water standards. Upon checking the location of this well, it was found to be situated in close proximity to an area of former shallow mining.

To expand on this erratic high-zinc determination, the EPA, during February 1986, collected 18 additional, hand picked, water samples from the study area. The analyses of these 18 samples showed 5 to contain metallic values above safe levels for human consumption. Of thse 5 well samples abnormal values for zinc were found in 2 wells, for cadmium and nickel in 1 well, for nickel in 1 well, and for lead in 1 well. The erratic nature and distribution of the zinc. cadmium, nickel, and lead values are quite puzzling, and suggest faulty analytical work. All 5 of these well sites were visited by the writer, and were found to be either located over, or closely adjacent to known ore deposits.

The presence of highly mineralized waters associated with oxidizing mineral deposits has been known since earliest settlement, with surface discharges being used for prospecting guides by the local miners. Where the ore minerals lie below the fluctuating water table levels, they remain inert under alkaline conditions.

Barks (1977) in his study of the groundwaters of the area states -- "Although wells located in or very near mines (ore deposits) may be seriously affected by the mine water, there does not appear to be widespread dispersion of highly mineralized mine water in the cherty limestones of the shallow aquifer."

The local residents living in areas of known zinc-lead mineral deposits are well aware of the possibilities of groundwater contamination resulting from the near-surface oxidation of these occurrences. Over the years the local people have provided their own alternative water supplies for domestic purposes. These include (1) using water from available Rural Water Districts; (2) using water from shallow, cistern-type reservoirs, constructed in areas having perched water tables; (3) drilling deeper water wells to depths below 400 feet to reach better quality water in the Ordovician formations; and (4) in isolated instances to haul water from outside sources.

Notwithstanding the assertions implied by the EPA report, the shallow groundwaters throughout Jasper County have been shown by Feder et al. (1969), and Barks (1977) to be of generally acceptable quality for most purposes, with the exception of drill holes penetrating solution structures containing oxidizing mineral deposits. Over most of the area the prime concern regarding the shallow water quality is from contaminated recharge sources, such as nitrate fertilizers, barnyards, cesspools, and industrial wastes.

Surface Water Contaminations

The qualilty of the surface waters in the principal drainage streams of the area have been described in the detailed reports by Feder et al. 1969), and Barks (1977). In these reports water analyses from spaced locations along both Center and Turkey Creeks show an average 10-fold increase in dissolved zinc content in the reaches lying downstream from tributaries draining areas of known mineral deposits undergoing oxidation. From periodic sampling along Center Creek during the years 1971 to 1975, Barks (1977) shows the increase in dissolved zinc to average 150 micrograms per liter at Carterville, and 610 micrograms per liter at Smithfield.

Such dissolved zinc values are far below the 5,000 micrograms per liter toxic values established by the EPA, and are not considered to be harmful to stream aquatic life.

Water analyses from the intermittent tributaries draining areas of former mining operations do show marked increases in dissolved zinc values during seasonal periods of heavy rainfall. These areas reresent special situations, and are further described below.

Runoffs from Mill Tailings

The mill tailings and boulder piles of the Oronogo-Duenweg Mining Belt consist primarily of the over-sized and crushed chert gangue rocks from the Sheet-Ground ore deposits of the area. This material should not be considered as a "chemical waste" in the sense of a bi-product from a chemical processing facility, but represents the nearly barren fragments of normal sedimentary rock after the zinc-lead fractions have been removed through gravity milling. Because of the "free-milling" nature of the Sheet-Ground" ore deposits, these boulder and chat piles contain the lowest zinc-lead values of any similar material in the Tri-State District.

Because of the hard, dense physical characteristics, and the clean milling properties of the Sheet-Ground cherts, they are much in demand for construction material, and provide a valuable asset to the local landowners. During past years millions of tons of this material have been sold for such uses as road metal, railroad ballast, abrasive sands, and as concrete and asphalt aggregates. At the present time between 80 to 90 percent of the boulder and chat piles have been sold and removed from the area, with the few remaining piles being held by the landowners for future sources of construction material.

As part of the ground and surface water report by Barks (1977), reconnaissance discharge and seepage samples from eight tailing pile areas were analyzed. These samples were collected during a period of moderate rainfall at points as close as possible to their source. The analyses showed these waters to be more mineralized than the water from Center Creek (upstream from the tailings areas), and contained zinc, lead, copper, and cadmium in moderate to high concentrations. The conclusions from this study showed that the lead, copper, and cadmium were precipitated rapidly near the source after mixing with higher pH water, and that the dissolved zinc was diluted to acceptable levels from other water sources.

In addition to the reconnaissance sampling of runoff water from tailing piles, the Barks (1977) group selected a 7-acre tailings site for a special Small Area Storm Runoff study located in the Oronogo-Duenweg area. This test program covered a period of 9 days, during which time the site area received a 5.14 inch rainfall. The analyses of the surface runoff waters at the test site showed similar results and conclusions as with the reconnaissance testing described above. This test work also demonstrated that contaminations from tailing pile runoffs are of a seasonal nature, and largely contained at their source.

Stream Sediments

Another of the potential "health" hazards, as described by the EPA, is the presence of oxidized and sulfide ore minerals in the bottom sediments of certain perennial streams. These ore-forming minerals represent alluvial wash-material from eroded near-surface mineralized outcrops and mill tailings. The ore minerals themselves occur as solid particles of various grain sizes, and are widely dispersed in the alluvial fill of stream bottoms located downflow their point of origin. Since these ore minerals are largely insoluble, their contributions to stream water contaminations is relatively insignificant.

During February 1986 the EPA collected 15 stream sediment samples at selected localities, with 5 being in the Shoal Creek area, and 10 from Center Creek and its tributaries. The chemical analyses of the these samples showed very high, but erratic, values for zinc, cadmium, lead, and nickel, which suggest poor sampling techniques that may have included enriched pockets of the ore-forming minerals. Accurate analyses of unconsolidated alluvial material can only be accomplished through "bulk-sampling," followed by careful crushing and screening.

A detailed investigation of stream bottom sediments has been previously made by Barks (1977), with 5 reconnaissance samples being obtained from downflow sites in Center, Turkey, and Short Creeks, plus 15 samples from seepage-run tests along a 26 mile reach of Center Creek. The analytical results showed low to moderate increases in zinc and lead values at sampling sites receiving drainage from areas of known ore deposits. In the Center Creek study the samples from downstream sites (to the mining areas) showed an average increase in zinc and lead content of about 25-times the background values upstream. The average upstream values for zinc were about 100 ug/g, and 20 ug/g for lead. At the downstream sites the zinc content averaged 2,500 ug/g, while that of lead averaged less than 500 ug/g.

It is of interest to note, that although the streams of the area have accumulated minor qualtities of zinc and lead minerals in their bottom sediments from surface erosion, the total dissolved zinc ranges from 20 ug/L upstream to near 400 ug/L downstream, with the dissolved lead varying from about 10 ug/L to near 20 ug/L respectively. These values are a far cry from the EPA safe water limits of 2,500 ug/L for zinc, and 50 ug/L for lead.

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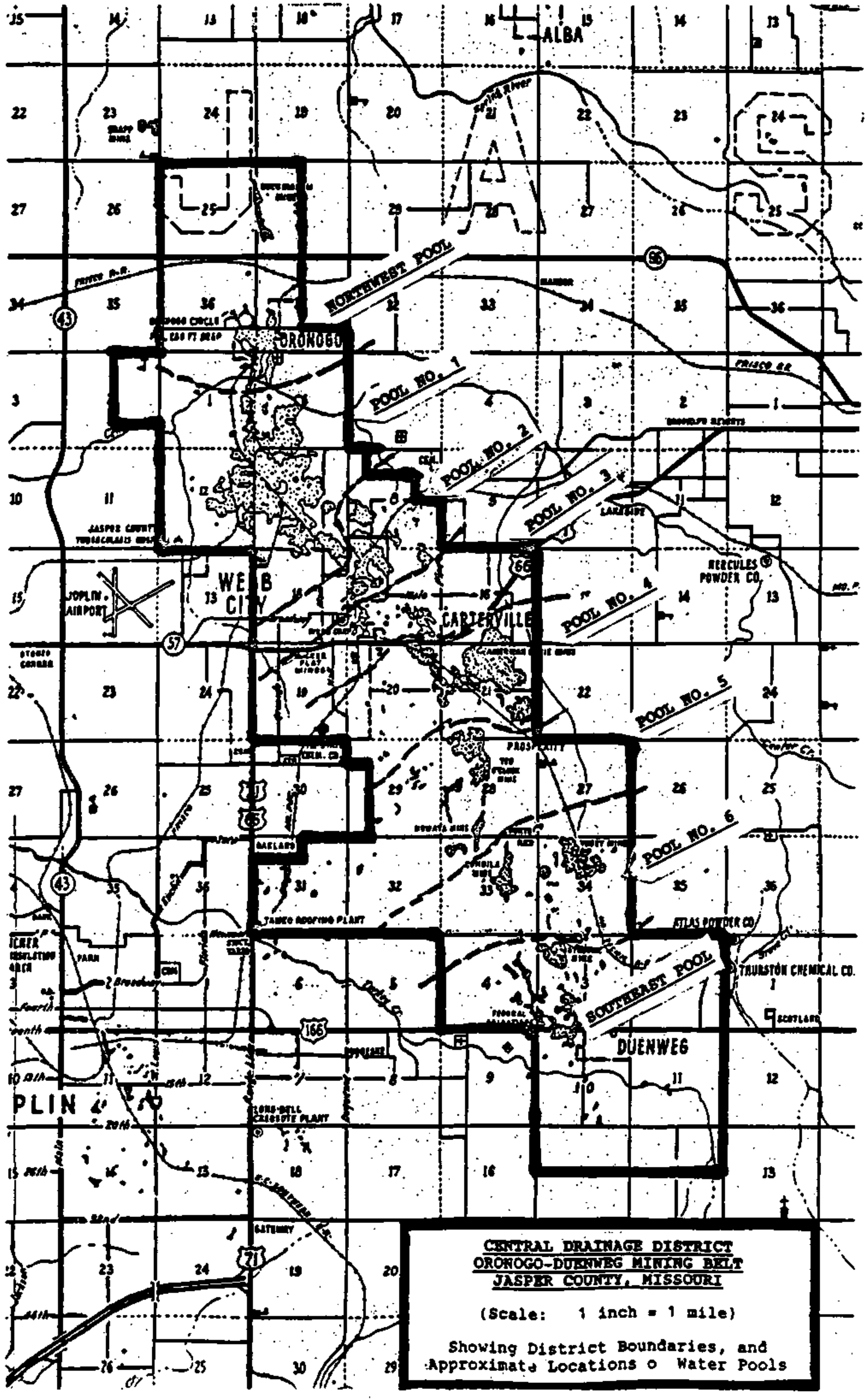

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